A.D. 1857, 30th NOVEMBER. N° 2976.

SPECIFICATION

OF

DANIEL KINNEAR CLARK.

FURNACES, &c.

LONDON:
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1858.

A.D. 1857, 30th *November*. N° 2976.

Furnaces, &c.

LETTERS PATENT to Daniel Kinnear Clark, of 11, Adam Street, Adelphi, in the County of Middlesex, Civil Engineer, for the Invention of "Improvements in Furnaces for Promoting the Combustion of Fuel without Smoke, and the Communication of Heat, specially adapted to Steam Boilers."

Sealed the 21st May 1858, and dated the 30th November 1857.

PROVISIONAL SPECIFICATION left by the said Daniel Kinnear Clark at the Office of the Commissioners of Patents, with his Petition, on the 30th November 1857.

I, Daniel Kinnear Clark, of 11, Adam Street, Adelphi, in the County of Middlesex, Civil Engineer, do hereby declare the nature of the said Invention for "Improvements in Furnaces for Promoting the Combustion of Fuel without Smoke, and the Communication of Heat, specially adapted to Steam Boilers," to be as follows:—

First, in a method of improving the combustion of fuel and preventing smoke by projecting jets of steam into the furnace or fire-place; the openings may be so formed as to spread the jets as they expand, so as by their action to divert and mix the gases as they rise from the coal, and the jets may be directed either over or through the fuel.

Second, in a method of accomplishing the same object by projecting jets of steam through apertures in the sides or other part of the fire-place, so as to draw air with the steam into the fire-place, and to diffuse it over or through the fuel, in order to become mixed with the gases as they are generated, and to burn them. The air and steam may be mixed previously to entering the fire-place, if preferred.

Third, in a method of accomplishing the same object by projecting jets of air into the fire-place over or through the fuel, impelled by forcing apparatus.

Fourth, in further mixing and consuming the gases by projecting steam, air, or a combination of both, into a mixing chamber, auxiliary to the furnace, or by the insertion of diaphragms made distinct from the body of the chamber, and capable of being readily disconnected for repair or renewal.

Fifth, in a method of economising fuel in locomotive boilers by the application of descending flues, forming a heat-trap, through which the products of combustion are passed previously to ascending into the chimney.

SPECIFICATION in pursuance of the conditions of the Letters Patent, filed by the said Daniel Kinnear Clark in the Great Seal Patent Office on the 29th May 1858.

TO ALL TO WHOM THESE PRESENTS SHALL COME, I, DANIEL KINNEAR CLARK, of 11, Adam Street, Adelphi, in the County of Middlesex, Civil Engineer, send greeting.

WHEREAS Her most Excellent Majesty Queen Victoria, by Her Letters Patent, bearing date the Thirtieth day of November, in the year of our Lord One thousand eight hundred and fifty-seven, in the twenty-first year of Her reign, did, for Herself, Her heirs and successors, give and grant unto me, the said Daniel Kinnear Clark, Her special licence that I, the said Daniel Kinnear Clark, my executors, administrators, and assigns, or such others as I, the said Daniel Kinnear Clark, my executors, administrators, and assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an Invention for "IMPROVEMENTS IN FURNACES FOR PROMOTING THE COMBUSTION OF FUEL WITHOUT SMOKE, AND THE COMMUNICATION OF HEAT, SPECIALLY ADAPTED TO STEAM BOILERS," upon the condition (amongst others) that I, the said Daniel Kinnear Clark, my executors or administrators, by an instrument in writing under my, or their, or one of their hands and seals, should particularly describe and ascertain the nature of the said Invention, and in what manner the same was to be performed, and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said Letters Patent.

NOW KNOW YE, that I, the said Daniel Kinnear Clark, do hereby declare the nature of my said Invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

My Invention relates, first, to certain improvements in furnaces, for effecting the complete combustion of fuel and the prevention of smoke.

Secondly, to the application of descending flues in locomotive boilers, for the better absorption of heat from the products of combustion.

With respect to my improvements in furnaces, one or more openings or passages to the furnace are formed through the sides or other suitable parts of it, or of adjuncts thereof, in free communication with the atmosphere for the admission of air; and one or more jets of steam are projected through these openings, in order to draw the air into the furnace, the action being like that of the blast in the chimney of a locomotive engine; and to diffuse and mix the air with the combustible gases as they are generated, and so to burn them and economise fuel. The jets of steam are employed as instruments, or means of forcibly inducting air into the furnace, and diffusing and impinging it upon and amongst the gases and the fuel. The steam inducted air columns or currents may be introduced at any level, and in any direction, above, through, or beneath the fuel. When introduced at or about the level of the fuel, they spread over the surface, and smoke is effectually prevented. When they are directed upon the fuel from above, or into, or through the fuel, it is raised to a state of intense ignition by the forcible induction and impingement of air upon it, whilst smoke is thus also prevented, a considerable proportion of solid fuel is consumed by the inducted air.

The Invention embraces the method of injecting steam alone into furnaces through flat jet orifices, in order to spread the steam in sheets over the fuel and promote combustion.

The Invention consists, further, in methods of delivering air into furnaces under pressure. First, by discharging air in jets through openings in the sides or other suitable parts of the furnace, or adjuncts, in free communication with the external air, so that air may be drawn into the furnace in company with the jets of air, similarly to the action of the steam jets already described; secondly, by delivering the air in sheets by means of flat jet orifices. A small proportion of water may, if preferred, be mixed with the air, being introduced into the air passages or otherwise. The air may be forced into the furnace by any of the ordinary mechanical means.

Steam inducted air currents, or pure air currents, may be delivered in the methods above described, amongst the combustible gases, in an auxiliary chamber or chambers, or in the flues apart from or beyond the furnace, or in or near the chimney; in order that by themselves, or conjointly with currents in the furnace, combustion may be promoted and smoke prevented.

In administering air by steam induction, it is desirable that the greatest quantity of air should be drawn in with the lowest expenditure of steam. The openings or passages for air may be tubular, conical, bell-mouthed, or otherwise formed for the free induction of air. The steam jets may be discharged from round, flat, rifled, or otherwise shaped orifices, so that the currents may spread conically or in flat fan-like sheets, or spirally, or otherwise, as may be desired. The passages to the steam-jet nozzles may be of any form; the pipes or passages should be large enough to carry the steam to the orifices at or nearly of the same pressure as in the boiler, and the jets should be delivered from contracted orifices with taper nozzles, terminating with the "contracted vein" or other form, suited to deliver the steam fully and freely. A very powerful draft by steam induction is generated from a jet orifice, about one-twentieth to one-thirtieth in diameter of the opening or passage for air; the nozzle being placed at a distance from the smallest part of the opening, equal to about three to four times its diameter. I do not bind myself by these ratios; the proportions may vary with the pressure and other circumstances; for instance, the greater the pressure, or the freer the draft, the smaller may be the jet orifice, and the larger the opening. In general, the jet should be so placed as, in expanding, to block or fill the opening, and give the longest practicable lead for the jet, that it may engage and induct the greatest quantity of air.

The currents may be delivered into receiving and distributing chambers conveniently situated, from which the inducted currents may be widely distributed within the furnace through any number of perforations or channels.

By a suitable disposition of cocks, or other appliances, within easy reach of the engineman or attendant, any one jet, or set or selection of jets may be put in operation, or disused above, below, or beyond the grate. The power of the jets in operation may be regulated by the same means or by means of variable jet orifices like the variable blast pipes of locomotives, or of alternative jets at the same or at distinct openings. Again, the draft may be accelerated by discharging two or more jets of steam into the same passage or channel, side by side, as with annular jets like "argand burners;" or, at different points in succession, particularly if the passage be of considerable length. The draft may also be accelerated through the passages by means of entrances to them, plain, or made with funnels or cowls turned towards the wind.

Figures 1, 2, 3, shew an application of the Invention to a locomotive boiler, in which steam is taken from the boiler by pipes *a* to branches *b*, at different levels at the sides of the fire box *e* and the ash-pan *f*. Tubular openings *c* are made through the sides, and jet nozzles *d* are pointed towards these openings, one to each, to project the currents directly across the furnace. One or more jets or rows of jets may be turned on, and the inducted currents delivered at any required level either above or below the grate.

Figures 4, 5, shew another arrangement; steam pipes are laid outside across the front and back of the fire box and ash-pan, and the openings are conical. The jet nozzles *d*, pertaining to the fire box, are inclined downwards to throw the currents upon the surface of the fuel, and to extend the range of their action at varying levels of fuel, as compared with that of currents delivered horizontally; further, that the currents may more directly impinge upon and burn the solid fuel as the combustible gases become exhausted, inducted air being in this way continuously utilised. The jet nozzles pertaining to the ash-pan are pointed upwards to direct the currents through the grate; and they afford a means of regulating the supply of air through the grate, either with or without the use of dampers at the ash-pan, the chimney, or elsewhere.

Figure 6 shews an application of downward currents through the upper part of the fire box, to descend upon the fuel and the gases.

Figures 7, 8, shew an application of flat jets through the back of the fire box, one at each corner; the openings into the fire box are flattened to match the jets.

Figures 9, 10, illustrate an application of inducted air currents to a locomotive boiler having a combustion chamber. Duplicate nozzles, direct and inclined, may be applied to each opening, as in Figure 11, and the one or the other may be put in action as required.

Figures 1 to 11 contain examples of the application of tubular, conical, and flat openings.

Figures 12 to 16½ illustrate other forms of openings, with the disposition of the nozzles and jets. The jets may be protected from side winds or other circumstances, within enclosures, one to each jet, perforated or otherwise formed to pass air freely, as exemplified in Figures 17 to 21; or, they may be grouped together within larger chambers, as in Figures 22, 23, 24. The reception of currents in distributing chambers is exemplified in Figures 25, 26, shewing a single current divided into streamlets, passed through a number of small passages; also, in Figures 27, 28, illustrating the reception of two or more currents in one chamber, and their diffusion through a number of openings.

Figures 29, 30, shew examples of nozzles for round jets.

Figures 31 to 34 shew two varieties of nozzles for flat jets; in the second of which the jet is deflected and flattened by a plate which forms part of the nozzle.

Figures 35, 36, shew the jet flattened upon a plate or partition in the opening; Figures 37, 38, shew converging and diverging nozzles, with adjustable plugs, to regulate the strength of the jets; and they may be formed to give any degree of divergence; Figures 39, 40, shew an annular nozzle with two or more jet orifices to draw air internally and externally. The jet nozzles, singly or in numbers, may be placed on swivelling frames, so that their level, or their inclination at the same opening may be varied, as in Figure 41; or, so as to shift them from one opening to another at different levels, on swivels or on slides, as in Figures 42, 43, illustrating the application of swivels. In the same way, or by similar contrivances, the nozzles may be shifted laterally, and they may be adjusted to any required distance from the opening or passage, and the steam may be led to them by flexible tubes. The adjustable nozzles and steam pipes may be fixed in position by screws and sliding nuts or by ordinary set screws. The nozzles may also be constructed to slide telescopically towards or from the air openings. The nozzles may be cleared of obstructions by the application of small cleaning rods or wires fitted internally so as to slide and be pushed through the orifices of the nozzles; and the cleaning wires may be worked through small stuffing boxes at the back of the steam pipe by means of a simple mechanical arrangement within reach of the attendant, as indicated at *u*, *u*, Figure 41, and exemplified in detail in Figure 55; and which may be used also to regulate the strength of the jet. The action of the inducted currents is assisted by the use of a steam blow-pipe in the chimney when the steam is shut off from the engine to draw off the products of combustion. The blow-pipe should have a contracted nozzle, and in locomotives it may be opened or closed by a simple obvious connection, simultaneously with the closing or opening of the regulator; the connection may be made with links, or levers, or otherwise, capable of being readily detached or attached.

Figures 44, 45, exemplify the use of my Invention in a marine boiler; the inducted currents *a* are introduced at the entrance to the furnace, and deflected upon and spread over the fuel; the currents *b* are thrown into the ash-pit, and the currents *c* are inducted into the auxiliary or combustion chamber behind.

the bridge to mix with the smoke as it passes over. The supply of air behind the bridge is brought from the front under a false bottom plate *f*, or it may be brought from above through the pipe or passage *d*, shown in dot lining, having a cowl and an auxiliary jet *e* at the upper end to catch the wind and promote the draft.

Figures 46 to 50 shew various applications of inducted currents to stationary boilers in the fire-place and the flues; the air chambers and passages may be of brick, metal, or other material.

Figures 51, 52, shew the application of the method of inducted air currents to an ordinary furnace for melting iron.

The foregoing descriptions and illustrations have reference generally to the method of induction by steam jets; they are intended also to apply to the method of induction by air jets subject to obvious adaptions, and in the latter case a steam rotary reaction engine may be employed to drive a fan on a common shaft for the supply of air. Though I have, for convenience of illustration, selected the examples of my Invention for promoting the combustion of fuel without smoke, chiefly with regard to the furnaces of steam boilers, particularly of locomotive boilers, I do not confine it to any particular class or classes of furnace. Nor do I confine the application of the details illustrated and described to any one kind of furnace; details may obviously vary with the nature and construction of the furnace, but as elucidations of general design and arrangement, the details are applicable to furnaces generally.

The system of inducted air currents by steam jets or air jets above described affords a means of throwing air and steam into the furnace without exposure of any parts to the injurious action of the fire. At the same time it is applicable to plans for introducing air into furnaces by means of mid-feathers, arches, tubes, tuyers, partitions, walls, fire bars, or other structures within or about the fire-place or the flues.

The steam may be obtained from the boiler or from the exhaust passages of the engine; I prefer steam taken direct from the boiler. The steam or the inducted current may be superheated prior to its entering the furnace or other part, if preferred. The supply of steam for the induction of air currents to furnaces other than those of steam boilers, may be had from any steam boiler in the neighbourhood, or from a special boiler erected for the purpose. The steam may be filtered through diaphragms of metallic gauze or other means, to deliver it free of foreign matter and prevent obstruction of the nozzles; the steam pipes may be blown through and cleared out through cocks or plug holes. The steam pipes should be protected by being encased in larger pipes, or in felt, or both. The nozzles may be bushed with platinum, steel, or other suitable material, to prevent wear and enlargement. The method of inducted air currents is serviceable when introduced above the grate in moderating the draft through the grate, and checking the accumulation of clinker, and in preserving the fire bars. The process is applicable in the combustion of coal, preventing smoke and promoting economy, and it also facilitates the use of wood, small or inferior coal or other fuel, so further promoting economy.

With regard to the second part of my Invention, which relates to the application of descending flues in locomotive boilers, the products of combustion issuing from the flue tubes are led into and through descending smoke chambers or flues, after passing through which they ascend into the chimney, whence they escape in the usual manner. By thus interposing a capacious descending route, the heating surfaces of the boiler become enveloped in a bath of the hottest gases, which by their superior levity remain uppermost, and the relatively cooler gases descend and are drawn off at the bottom of the descent, and economy of heat and fuel is thus promoted. The descending flue should be very capacious, so as to allow the gases to circulate freely. Figures 53, 54, shew an application of the descending chamber or flue to a locomotive engine, in which the capacity and depth of the chamber *a* within the smoke box *b* are shewn as great as are consistent with the position of the engine on the rails; the course of the draft is indicated by arrows. Doors *c*, *d*, are added to clear out ashes, &c., or to open a direct communication with the chimney, if desired. The Invention is applicable to all boilers of the locomotive type.

Having now described my Invention, I may explain that I do not intend to confine myself to the precise arrangements or details herein-before described and illustrated, as many variations may obviously be made therefrom, without departing from the nature and objects of the Invention, and I do not consider it necessary to enter into details of such modifications; what I believe to be new and therefore claim as the Invention secured to me by the herein-before in part recited Letters Patent, according with and having reference to the descriptions herein-before contained, and the illustrative Drawings therein referred to and annexed, is as follows:—

First, the forcible induction of atmospheric air into furnaces or into combustion chambers or other adjuncts or flues connected therewith, and the forcible distribution of the air therein by means of jets of steam for the combustion of fuel and the prevention of smoke.

Second, the various forms and proportions of the jet nozzles and the air openings or passages for the efficient induction of air by the instrumentality of jets of steam.

Third, the use of one or more receivers or receiving chambers, to receive and distribute the inducted currents on their way to the furnace, or to its adjuncts or flues.

Fourth, the use of flat jet nozzles to inject steam alone into furnaces in flat fan-like sheets over or under the fuel for its combustion, and the prevention of smoke.

Fifth, the forcible induction and distribution of atmospheric air within furnaces or their adjuncts or flues, by means of jets of air forced by ordinary mechanical means, similarly to the method of induction by jets of steam, and with similar forms and proportions of jet nozzles and air passages, adapted to the means for the combustion of fuel and the prevention of smoke.

Sixth, the use of mechanical means for working a steam blow pipe in the chimney, in connection with the regulator or steam valve, specially applicable to the locomotive engine, with or without the use of special apparatus for the prevention of smoke.

Seventh, the application of capacious descending flues to boilers of the locomotive type, in order to detain the hottest of the products of combustion, and so to economise heat and fuel by the absorption of the heat into the boiler.

Eighth, the general forms, arrangements, and combinations of parts, or any mere modifications thereof, whereby the objects above-mentioned are to be effected as herein-before described, and according to the Drawings annexed.

In witness whereof, I, the said Daniel Kinnear Clark, have hereunto set my hand and seal, this Twenty-eighth day of May, in the year of our Lord One thousand eight hundred and fifty-eight.

D. K. CLARK. (L.S.)

LONDON:
Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty. 1858.

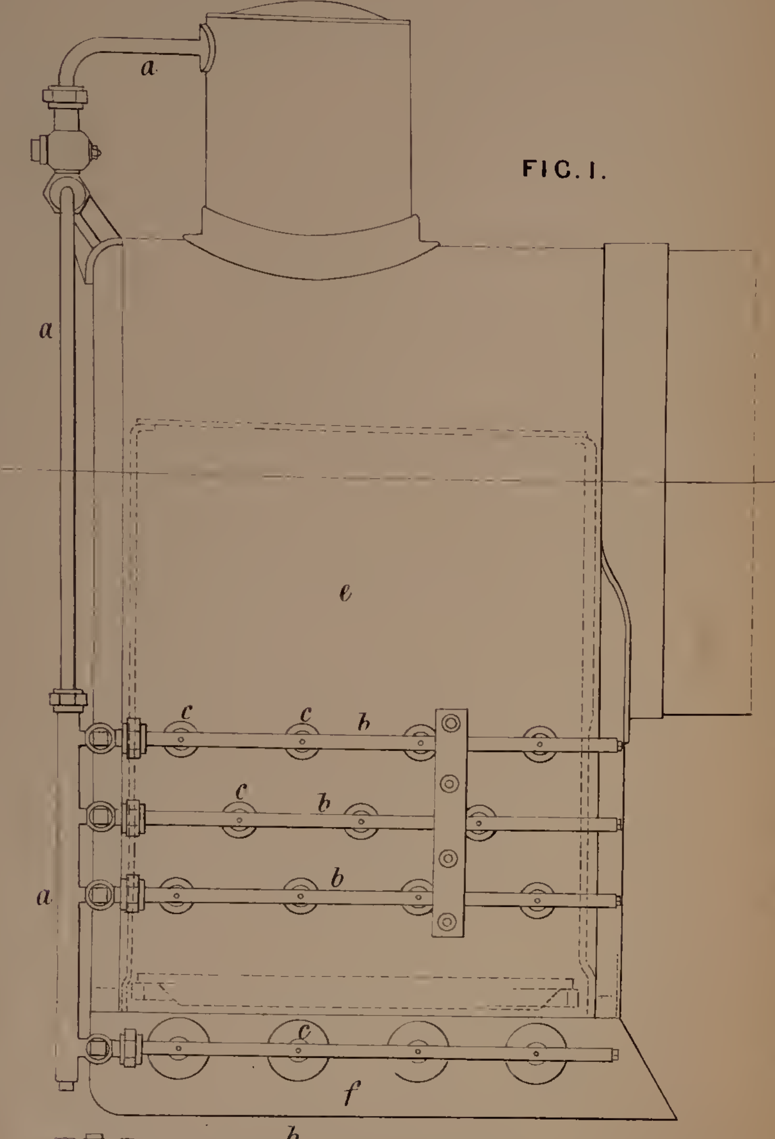


FIG. 1.

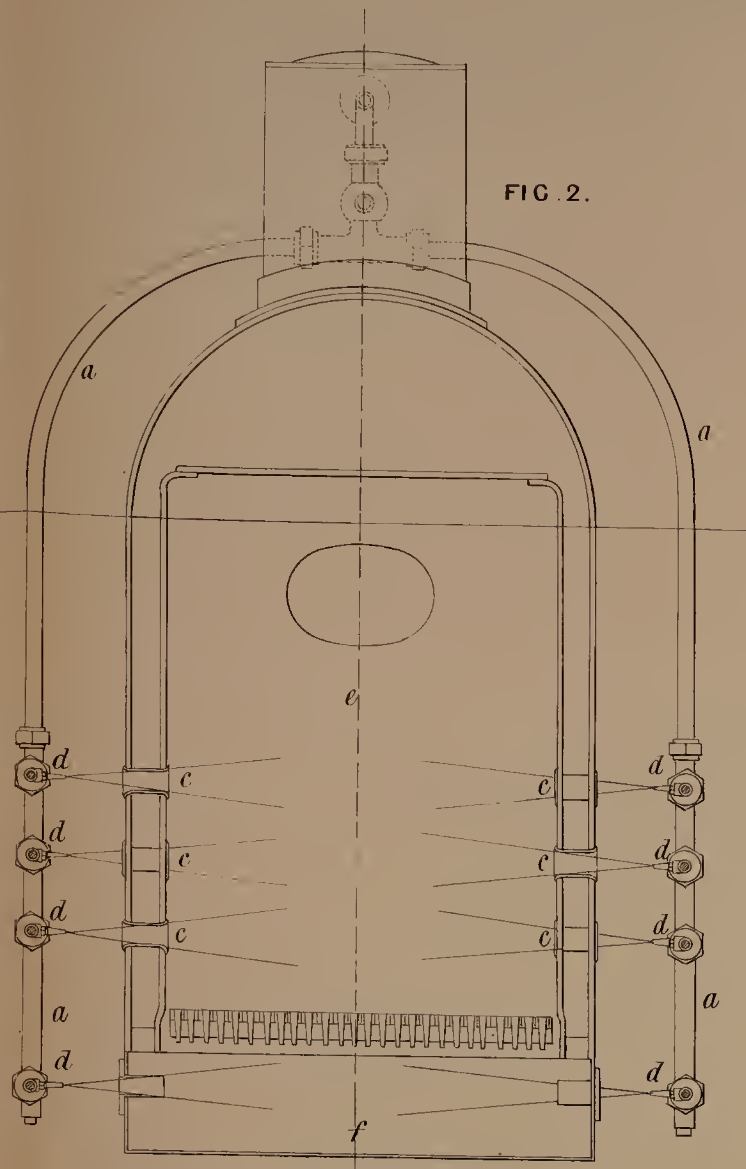
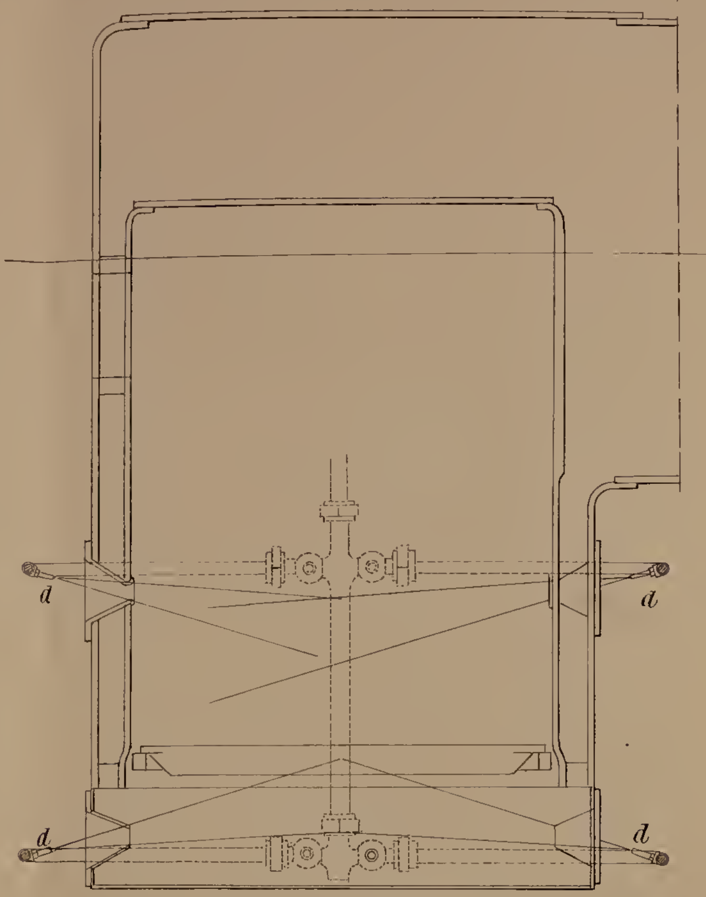


FIG. 2.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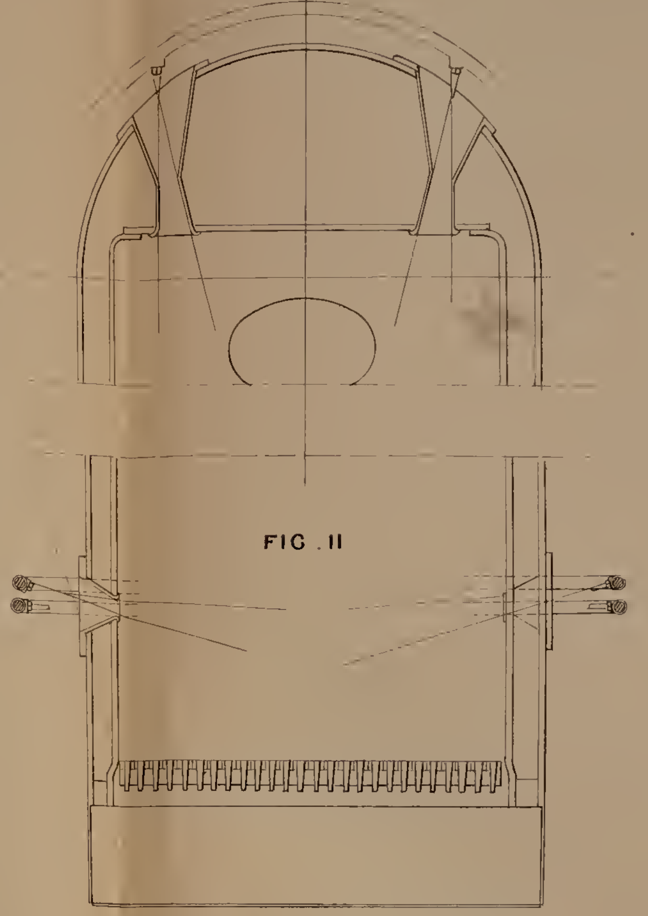


FIG 6.

FIG. 11

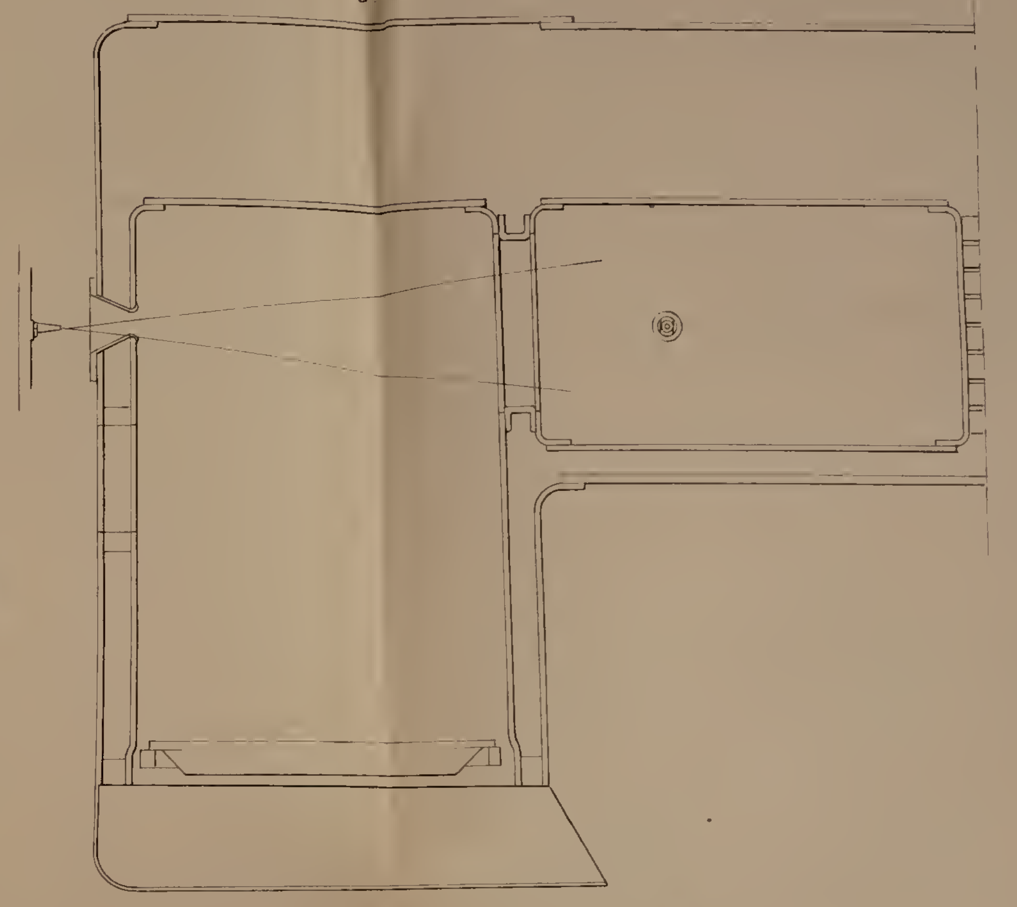


FIG 9.

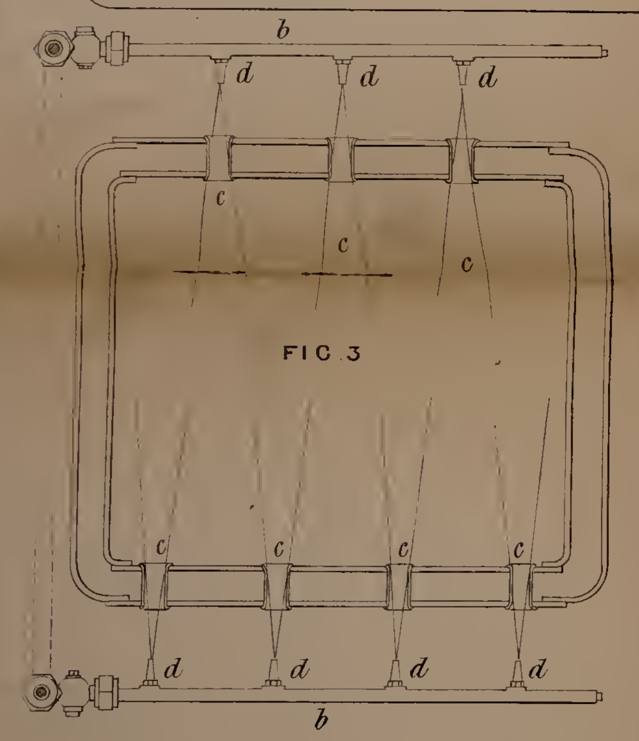
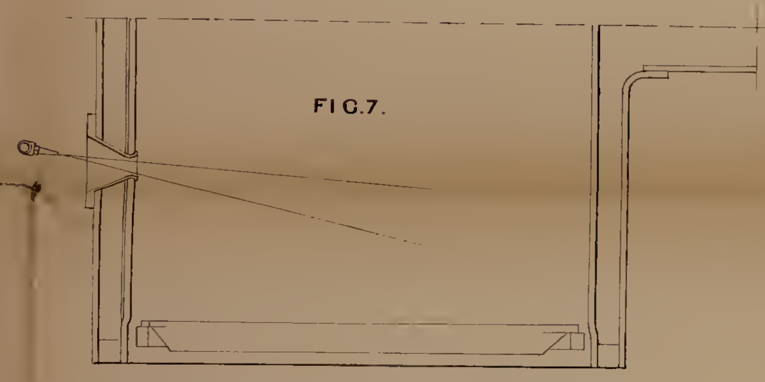


FIG 3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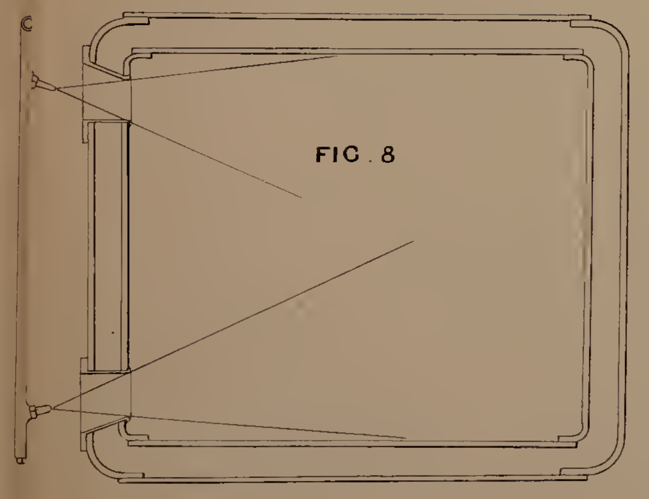


FIG. 8

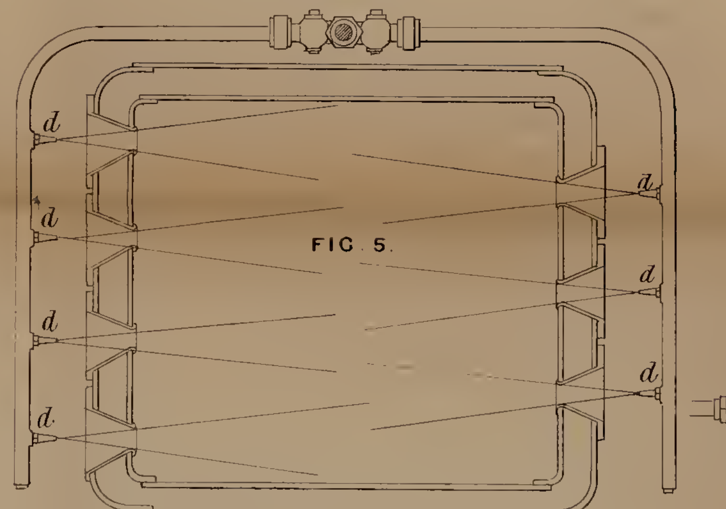


FIG. 5.

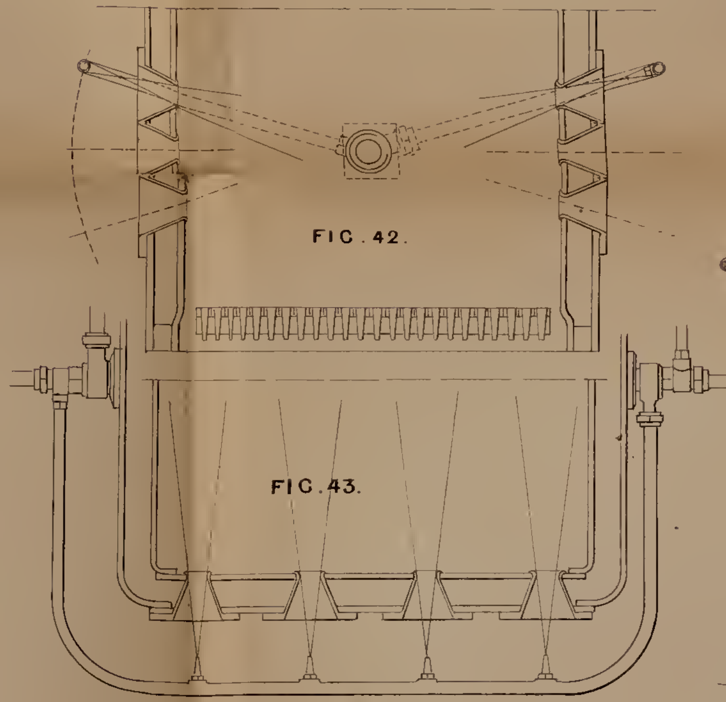


FIG. 42.

FIG. 43.

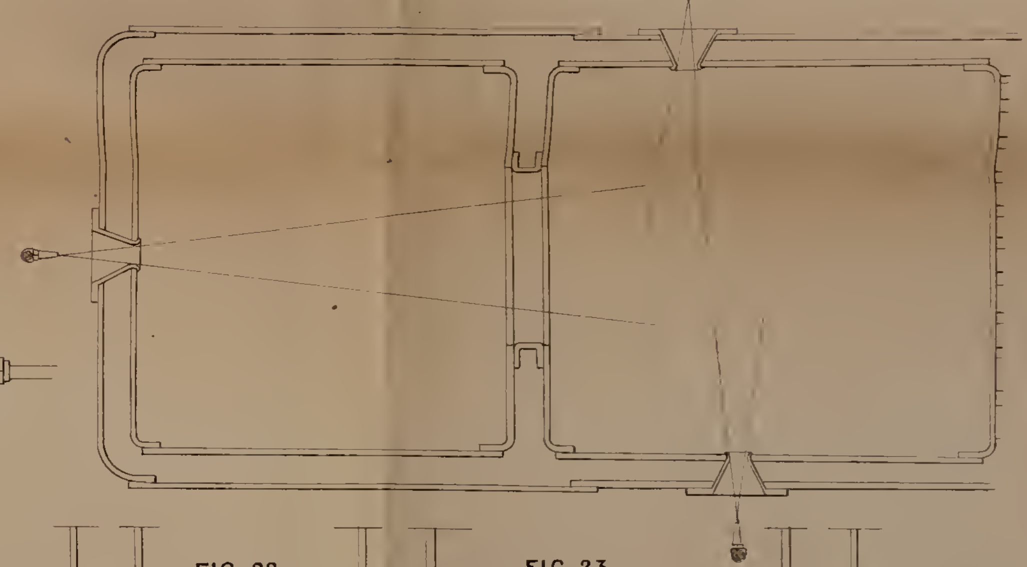


FIG. 10.

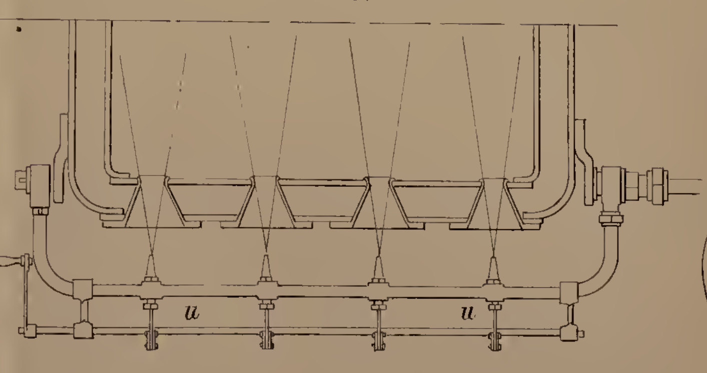
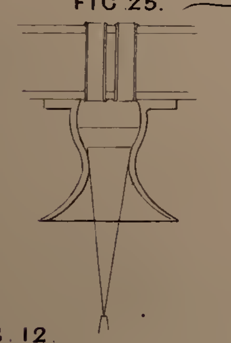


FIG. 41.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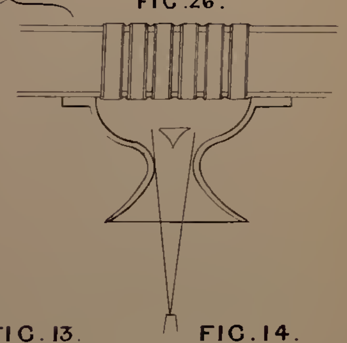


FIG. 26.

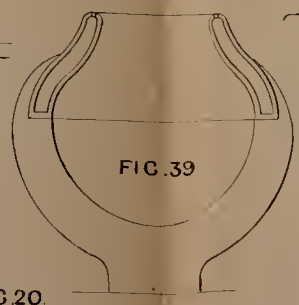


FIG 39

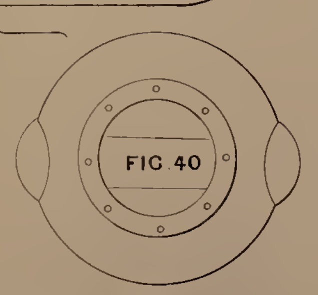


FIG 40

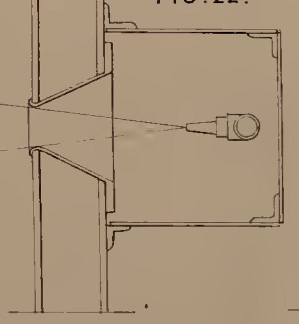
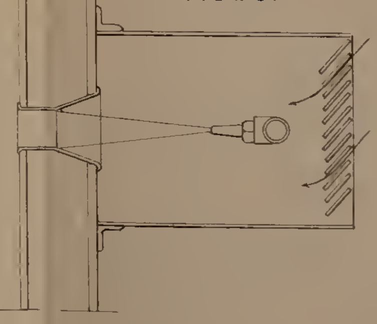


FIG. 22.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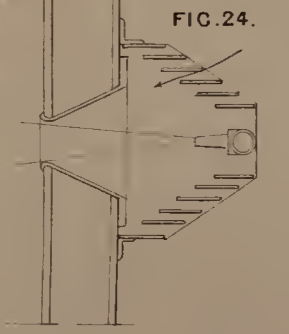
FIG. 24.

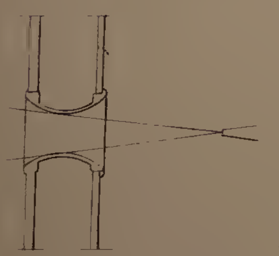
FIG. 12

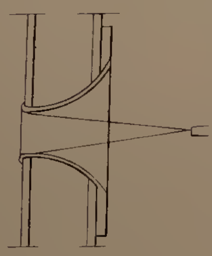
FIG. 13.

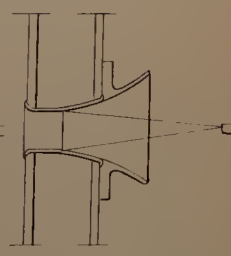
FIG. 14.

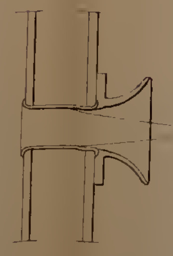
FIG. 15.

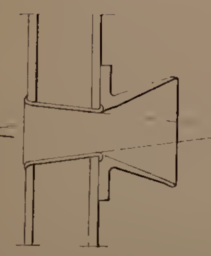
FIG. 16.

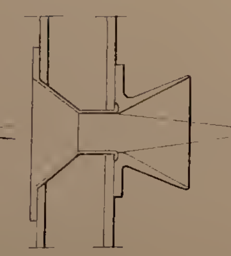
FIG. 16½

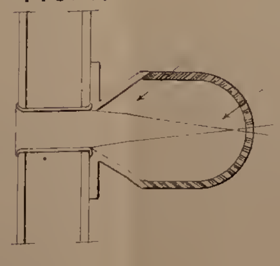
FIG. 17.

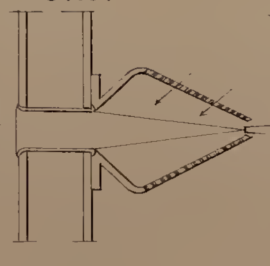
FIG. 18.

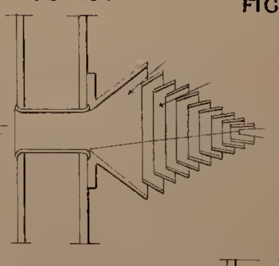
FIG. 19.

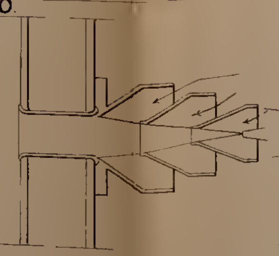
FIG 20.

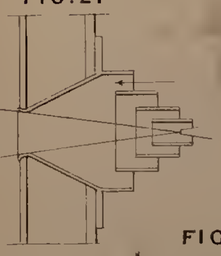
FIG. 21

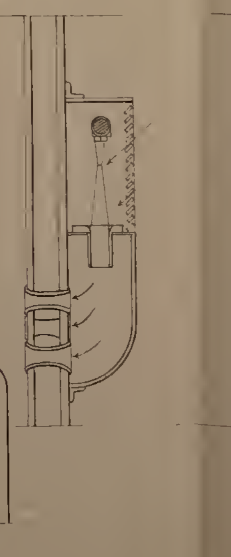
FIG. 27.

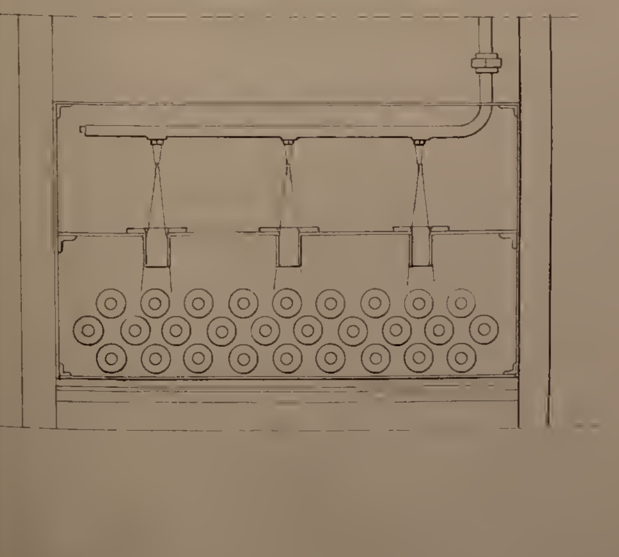
FIG 28

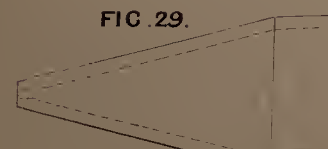
FIG. 29.

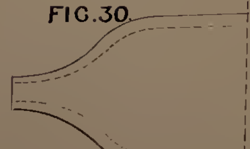
FIG. 30.

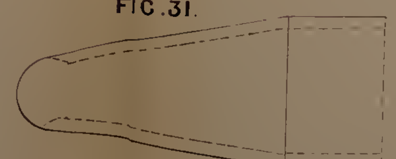
FIG. 31.

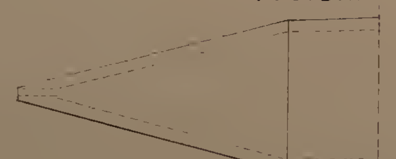
FIG. 32.

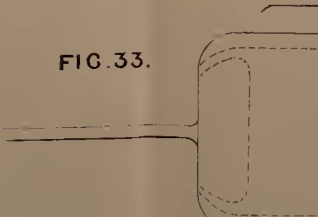
FIG. 33.

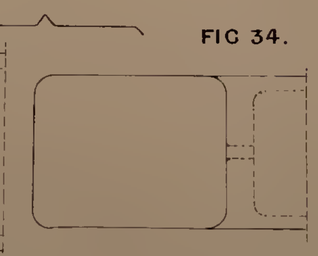
FIG 34.

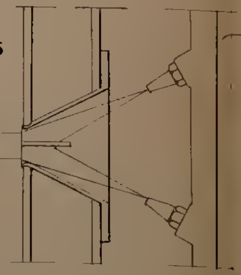
FIG 35

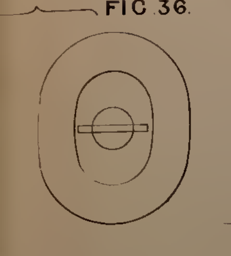
FIG 36.

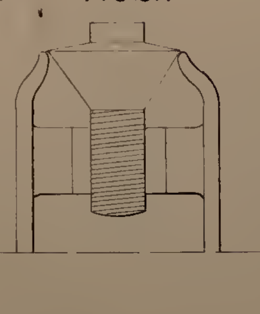
FIG. 37.

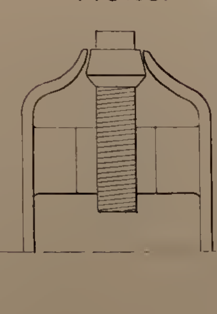
FIG 38.

The filed drawing is not colored.

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Printers to the Queen's most Excellent Majesty. 1858.

FIG. 44.

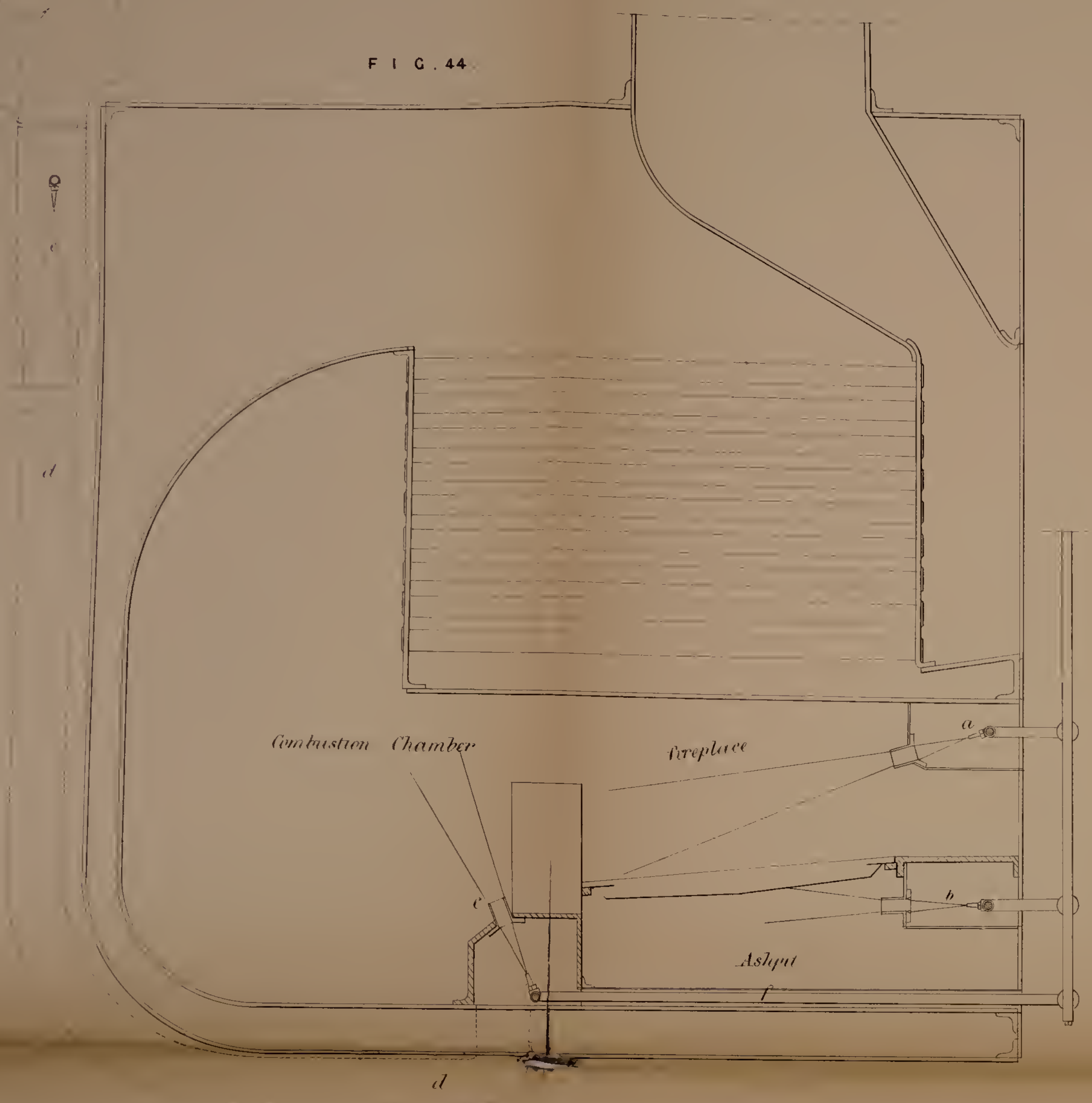


FIG. 45.

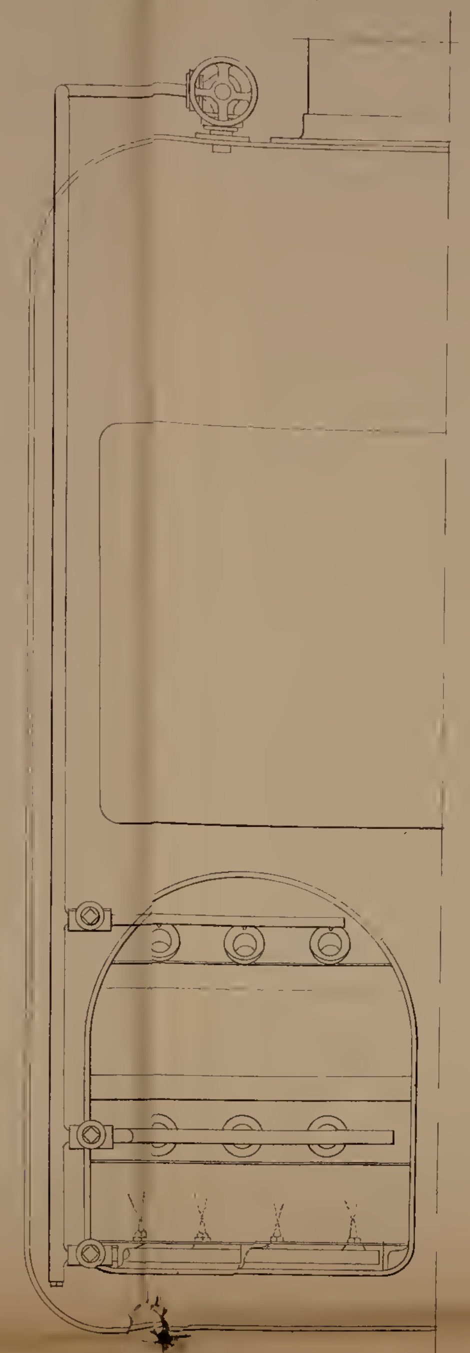


FIG. 46.

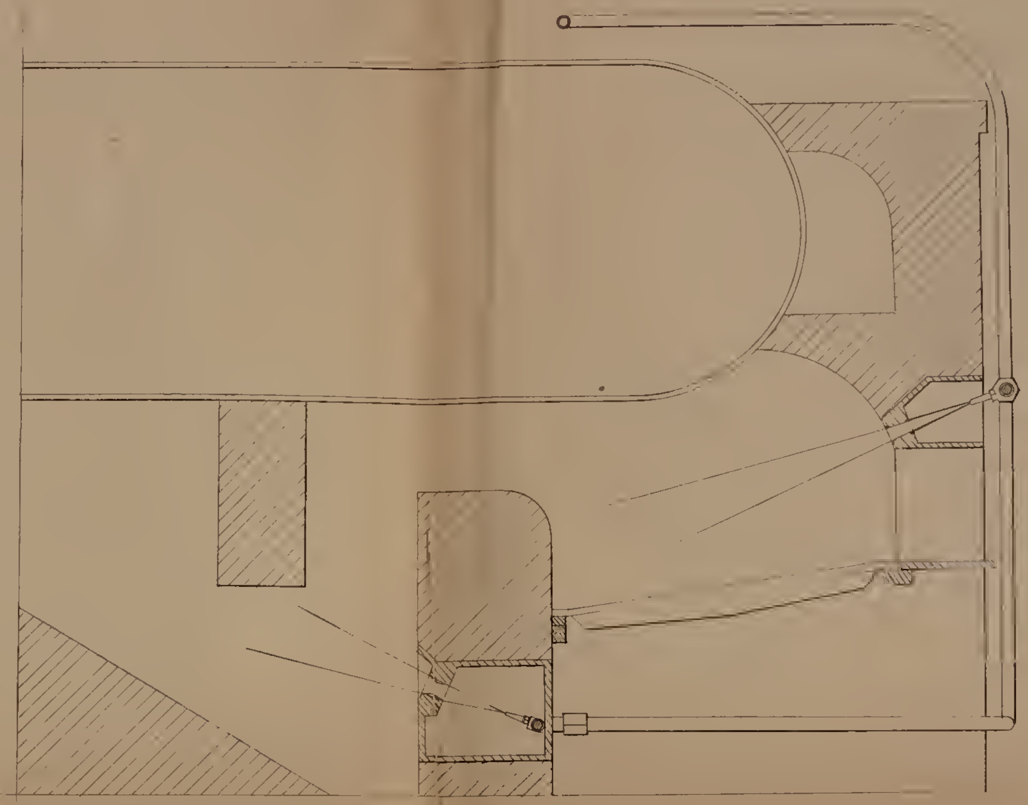


FIG. 47.

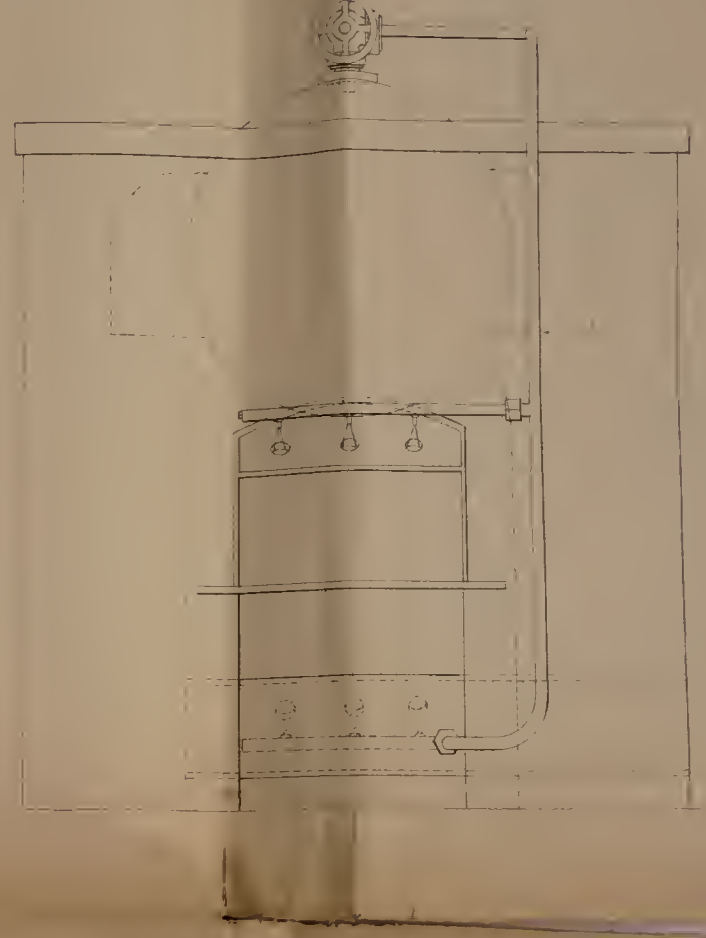


FIG. 48. *alternative plans.*

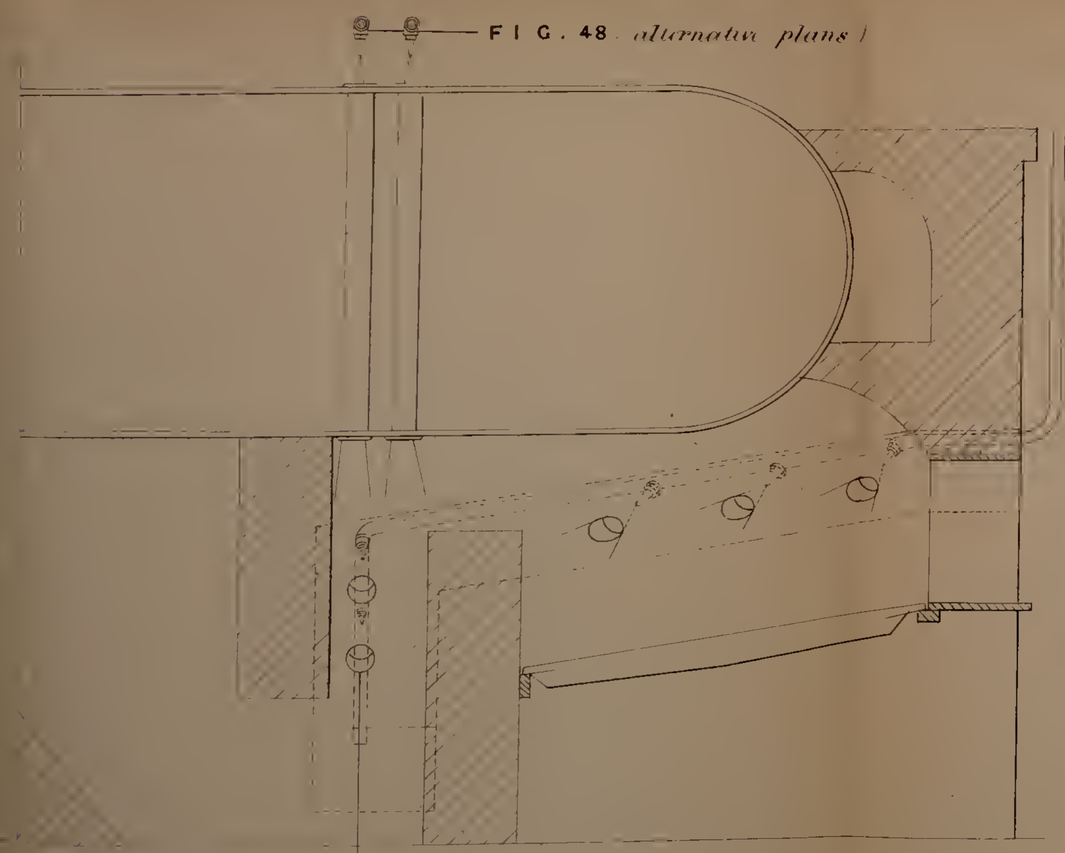


FIG. 49.

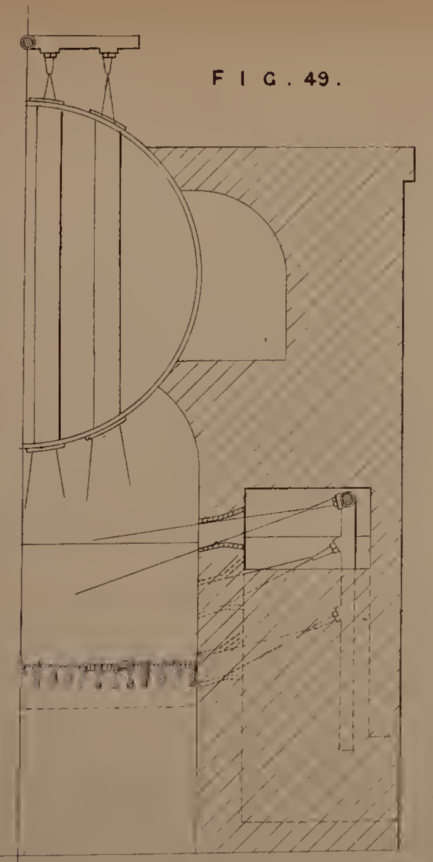


FIG. 52.

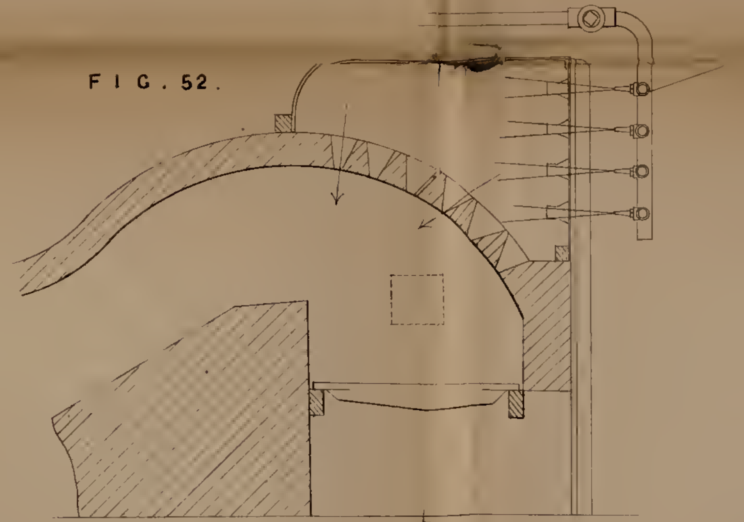


FIG. 51.

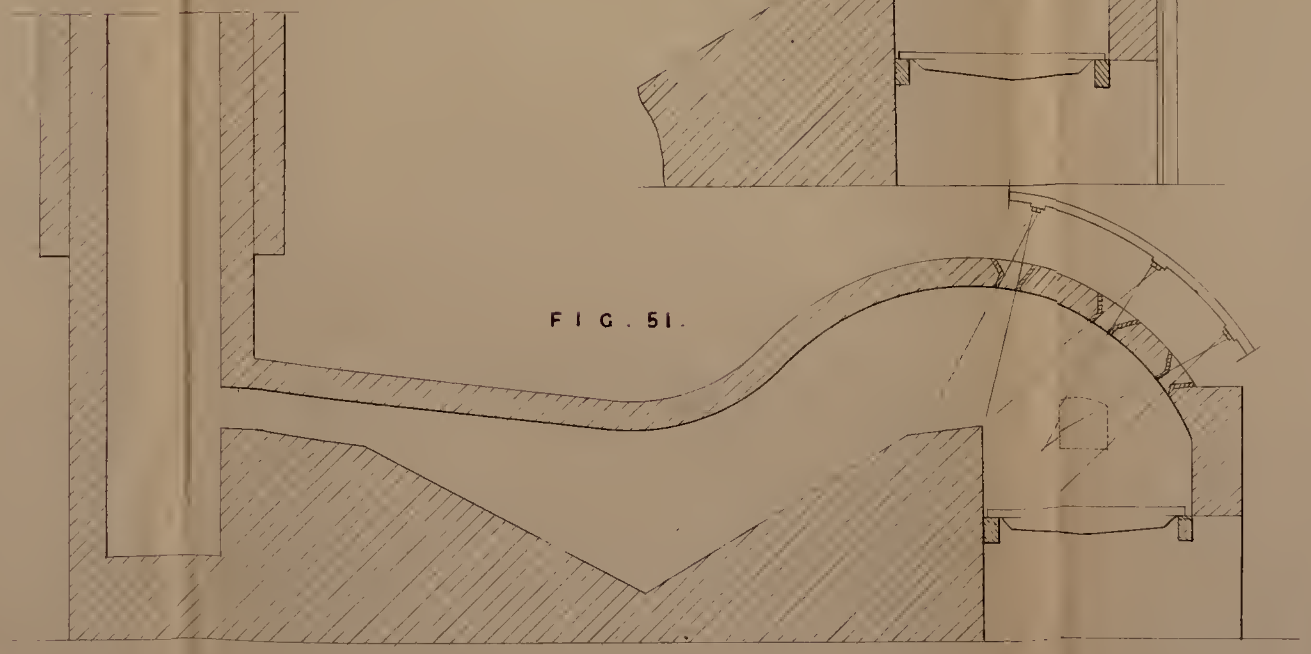


FIG. 53.

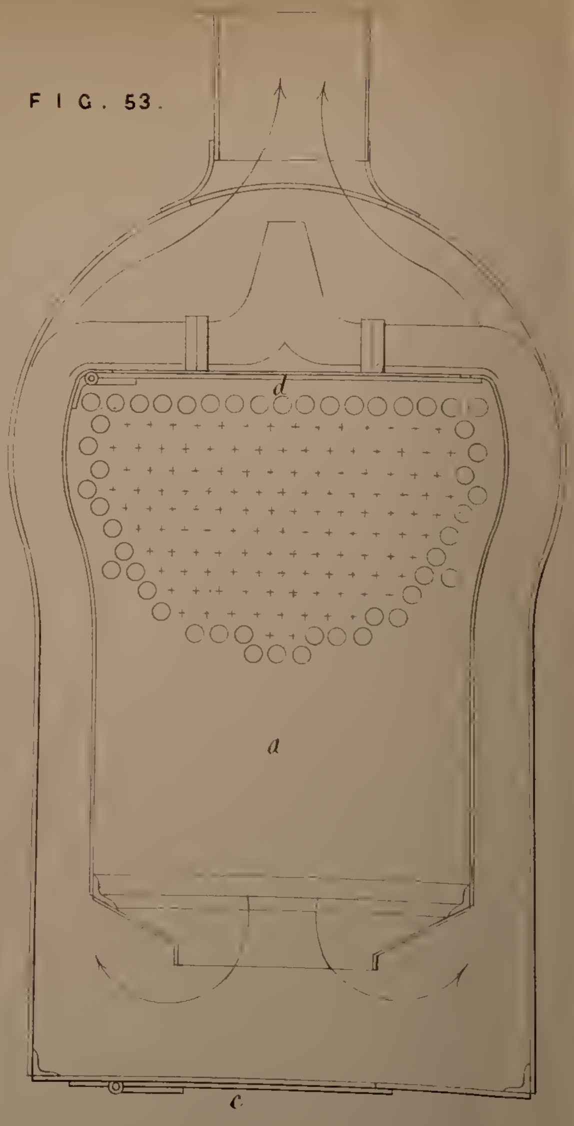


FIG. 54.

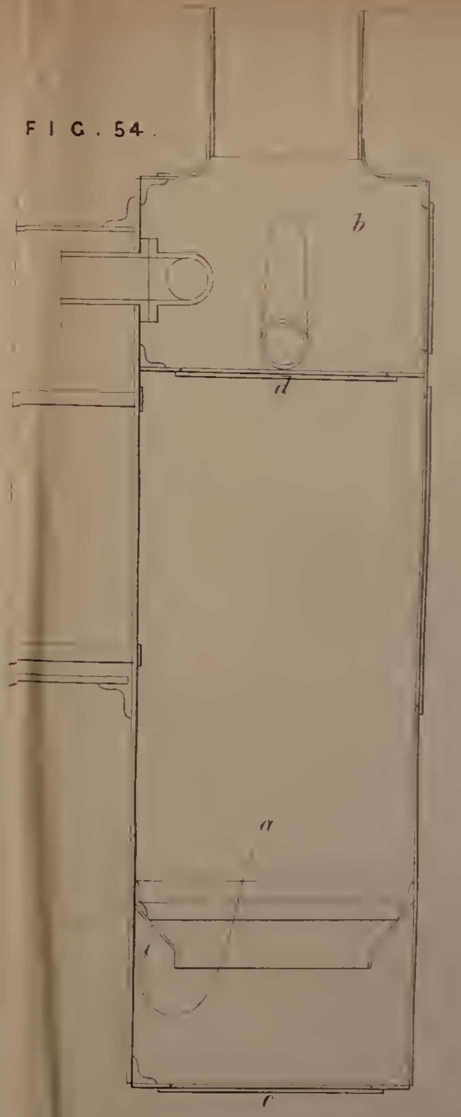


FIG. 50.

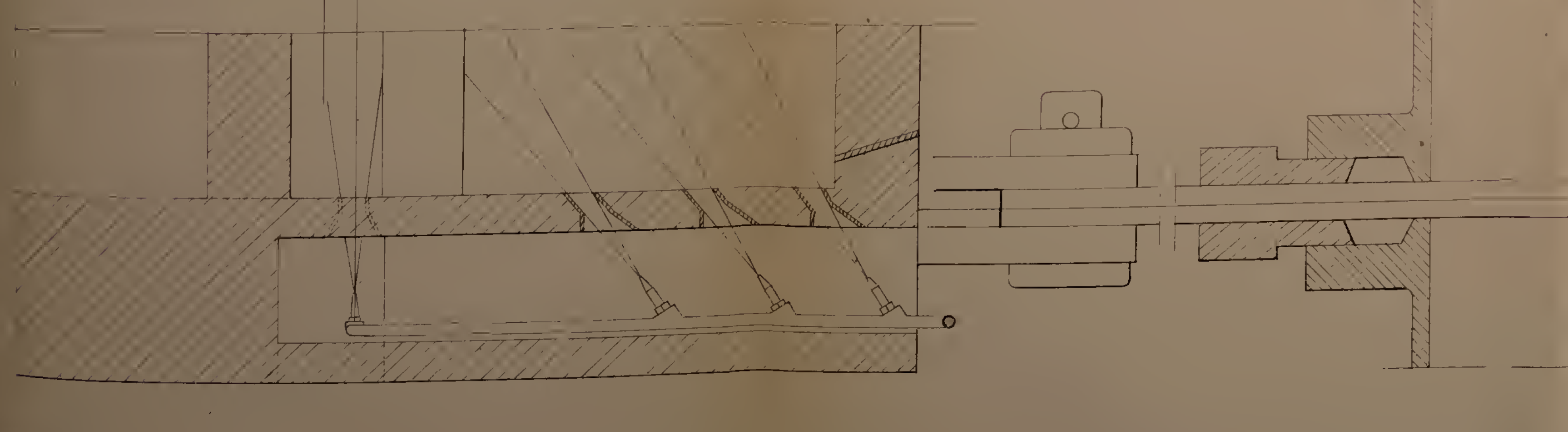
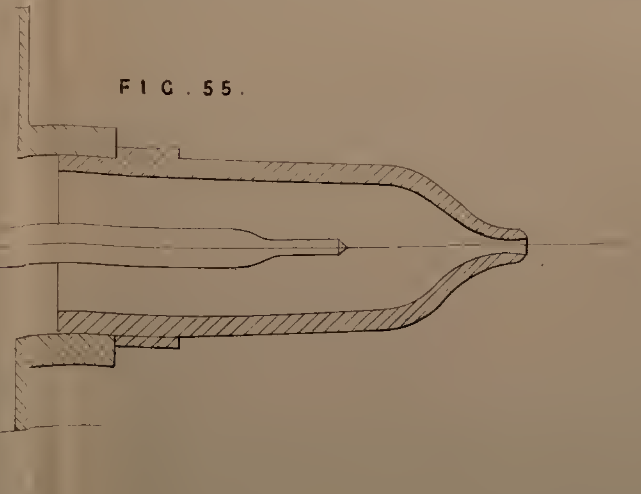


FIG. 55.



The Patent drawing is not colored.

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Printers to the Queen's most Excellent Majesty 1858.